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OCEANUS

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Here comes Daddy!

OCEANOGRAPHIC wives often lead lonely lives. Coping with the children, the house, the car and the bills. Shoveling snow in the winter or cutting grass in the summer. Not too uncommonly, having a baby while husband is enjoying his work at sea, or may be having a beer on the terrace of the City Hotel in Freetown, Sierra Leone.

Ladies, you deserve a well earned:

Salute!

'Guest' Editorial

VOL. X, No. 2, December 1963

The following is a quote from President Kennedy's address before the National Academy of Sciences on October 12, 1963.

. . . I would call your attention to a related problem — that is, the understanding and use of the resources of the seas. I recently sent Congress a plan for a national oceanographic program, calling for the expenditure of more than $2 billion over the next ten years. This plan is the culmination of three years' effort by the Interagency Committee on Oceanography, and it results from recommendations made at my request by the National Academy.

Our goal is to investigate the world ocean, its boundaries, its properties and its processes. To a surprising extent the sea has remained a mystery; 10 thousand fleets still sweep over it in vain; we know less of the oceans at our feet than of the sky above our heads. It is time to change this, to use to the full our powerful new instruments of oceanic exploration to drive back the frontiers of the unknown in the waters which encircle our globe.

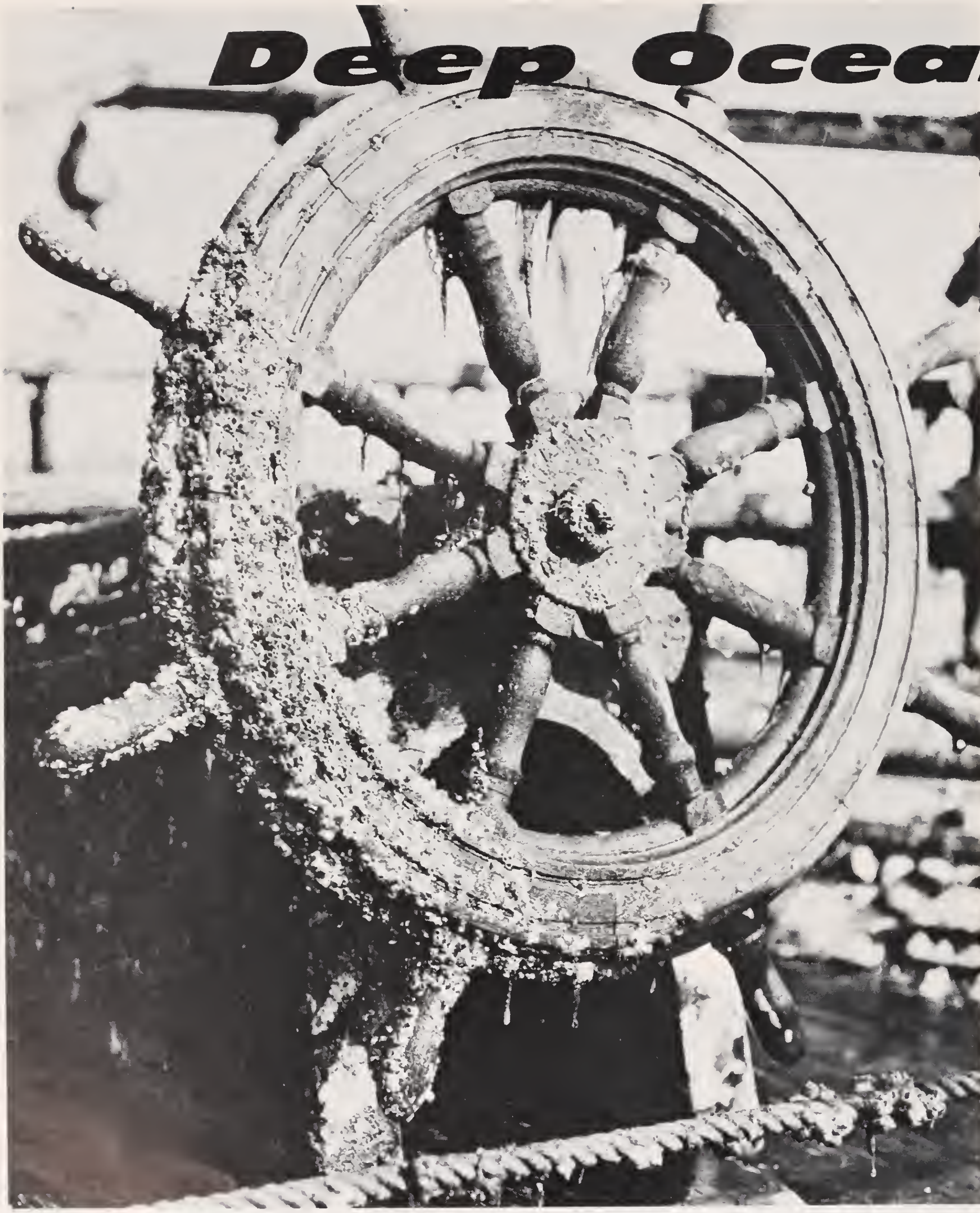
We need this knowledge for its own sake, and we need it to consider its bearings on our security and on the world's social and economic needs. It has been estimated for example that the yield of food from the seas could be increased five or ten times through better knowledge of marine biology.

Here again the job can best be done by the nations of the world working together in international institutions. As all men breathe the same air, so a storm along Cape Cod may well begin off the shores of Japan. The world ocean is also indivisible; and events in one part of the great sea have astonishing effects in remote places. International scientific cooperation is indispensable if human knowledge of the ocean is to keep pace with human needs.

A historic meeting occurred in the Indian Ocean as two brand new vessels met. Both named after famous predecessors, our R.V. 'Atlantis II' spoke the 'Discovery'.

MUNNS

Deep Ocean



The recent program of anchoring instruments in the deep sea and the ability of submarines to stay submerged for long periods of time have led to a new investigation of biological fouling.

Marine Fouling

By H. J. TURNER

"MARINE fouling" is a term which is applied to the assemblage of attached organisms that accumulate and grow on structures submerged in the sea by man. It is derived from the adjective: *foul*, which has a long string of meanings beginning with "offensive to the senses" and continuing with numerous others, all suggesting offensiveness or detriment to man. Anyone who has anything to do with the sea knows how fouling can be detrimental. It slows down ships, distorts sonar signals, disrupts the flotation of buoys and clogs salt water lines, to mention a few detriments. One notable exception in the oyster industry occurs when collectors, introduced into the marine environment, become "fouled" with young oysters to the delight of the oyster grower. This is fouling in the strict sense of the term, but one never hears an oysterman call it that. However, if the oyster spat collectors accumulate other kinds of organisms that inhibit the settlement of oysters, "fouling" is only the mildest of terms used.

The effects of fouling can be quite severe. A fast ship whose hull is inadequately protected from fouling may require a fuel consumption increase of as much as 50% to maintain standard speed in as short a period as six months. Combat vessels operating in tropical waters may require drydocking as often as every two months because fouling of the sound equipment distorts the signal and renders it ineffective. Accumulations of organisms in fire mains of ships may render them completely inoperative in the event of an emergency. Even land installations suffer. One power company in New England whose condensers are cooled with sea water has had to shut down completely for several hours at least once a year to clear the mat of organisms from the walls of the intake tunnel. This entailed not only the cost of the labor of the cleanout but also the buying of power from neighboring companies at the rate of hundreds of dollars per minute.

The manner in which the fouling community develops is relatively simple. Organisms in the natural marine environment attached to rocks, shells and debris produce minute free-swimming larvae during the breeding seasons which may vary from one species to another. In most cases the number of larvae resulting from a single pair of parents runs from the hundreds of thousands to millions.* The larvae then pass through a period of development which may be as short as a few hours or as long as several months depending on the species. In general the swimming powers are not great so that transportation and dispersal is accomplished by water currents. Finally, at the end of the free swimming period, larvae that come in contact with a solid surface cement

*See: "Clams," OCEANUS, Vol. III, 1., "Larvae in the Open Sea," Vol. IX, 3.

Extensive fouling of an intake pipe at a New England electric plant caused high annual maintenance costs. The photograph was made four months after the tunnel was cleaned.

themselves to it and metamorphose into a miniature edition of the adult form. There is some evidence that the free-swimming period is somewhat flexible, which gives the larvae a little leeway in finding their final homes. After attachment and metamorphosis, growth takes place and the fouling community develops.

Research during World War II disclosed a number of significant facts about marine fouling. It is usually more intense in the tropics where the breeding seasons are longer and growth more rapid than in the cooler waters. It is also generally more intense in bays and harbors than in nearby open waters because of retention of the larvae in the semi-enclosed environment. It also appears to decrease in intensity with increasing distance from shore and also with depth on structures moored in deeper waters. The evidence for the latter is somewhat inadequate because until recently the only structures moored at appreciable distances from shore were a limited number of buoys marking swept channels and these were seldom placed in depths exceeding a few hundred feet.†

Telegraph cables

Knowledge of the kind of fouling that may exist in the deep waters of the open ocean is derived from a few scattered reports. One of the earliest concerns a telegraph cable that parted at a depth of 1200 fathoms in the Mediterranean in 1860. Forty miles of the cable were retrieved for repairs and it was noted that various kinds of living organisms were attached to the covering. Corals were found near the break which had occurred in 1200 fathoms and other forms including molluscs, worms, bryozoa and hydroids occurred where the cable had lain at lesser depths. This was a significant biological discovery because it had been thought that there was little or no life below the depth to which sunlight penetrated. There are other records of fouling on submarine cables but only a few have found their way into the scientific literature.

Enraged whale

Fouling as it occurs near the surface of the deep oceans is known from drifting mines, derelicts and other kinds of flotsam. Here the most prominent organism appears to be the goose barnacle.§ These are so characteristic of open ocean fouling that some people have thought that the presence of large ones on a drifting mine might be used to estimate how long the mine has been adrift. Some indication of the rate of growth comes from an old record of a marine disaster. On November 20, 1820 the whale ship 'Essex' out of Nantucket was rammed by an enraged sperm whale in the Pacific Ocean at Latitude 0.°30′ N., Longitude 120° W. and her planking was so badly stove in that she sank rapidly. The crew took to the whale boat and spent ninety days making for shore. Many died of starvation and exposure and it is

†See: "Deep Ship Worms," Vol. VIII, 2.
§See: "Report from the North", Vol. X, 1.

rumored that some indulged in cannibalism. The survivors told that they had found "clams" large enough to eat growing on the bottom of the whaleboat after 25 days afloat. We now know that the "clams" were goose barnacles.

We at the Oceanographic Institution have made some preliminary observations on the kind of fouling that occurs in the open ocean in connection with a deep sea buoy project‡ on a string of instrumented anchored buoys extending from Cape Cod to Bermuda. Hydroids of various kinds were found on all the buoys and moorings from the surface down to a depth as great as 500 meters. The species varied from installation to installation. They occurred on the buoys, ropes, instruments, and on panels placed especially to collect fouling organisms. The other most prominent group was the goose barnacles which occurred on all installations 100 miles or so from shore and farther. These were limited to the top few meters and seemed to show a remarkable preference for Savonius rotors as a place of attachment. Here they could enjoy a free merry-go-round ride while at the same time altering the calibrations of the current meters so as to cast doubt on the data. Now, under contract with the

‡See: "Moored Buoys", Vol. VIII, 2.

Goose barnacles which were eaten by the shipwrecked crew of the whaleship 'Essex' are found in proliferation on the bottom of our moored buoys as well as on the polypropylene mooring lines.

Office of Naval Research, we are maintaining a special mooring near Bermuda which is designed to determine the extent and kind of fouling from the surface to a depth of 2,000 meters.

Until recently open ocean fouling has been of little practical importance. Modern ships move so fast through the water that their speed is above the limit at which larvae can attach (one to two knots) and modern bottom paints have excellent antifouling properties to protect the hulls while in port. Before the development of nuclear power, submarines could dive for only a few hours and their underwater instrumentation was not overly sensitive. Oceanographers obtained their information by suspending instruments on a wire which was reeled out and pulled back again immediately.

Submarines

Now modern nuclear submarines can be submerged for months at a time and one may surmise that their hulls are bristling with sophisticated instruments for navigation, detection and communication. It is also quite probable that fixed submarine detection apparatus and other antisubmarine warfare gear has been developed or is in the process of development. In addition oceanographers are attempting to perfect moored installations that make continuous measurements for long periods of time and either store the information or send it ashore by radio telemetry. In all cases there is considerable probability that the instruments or installations will be affected by fouling.

Fouling in the deep oceans presents some fascinating biological problems. It is difficult to imagine how a structure can become populated with organisms when the nearest parent stock is either hundreds to thousands of miles away in a lateral direction or else one or more miles straight down. Parent stocks on the ocean floor can probably be discounted because organisms adapted to the low temperatures of the great depths are seldom able to survive in the warm upper waters. Consequently, the source of the larvae probably must be shallow water populations adjacent to land masses. If this is the case, the numbers of larvae produced must be immense and the free swimming period quite long.

MR. TURNER is a marine biologist on our staff and lecturer in zoology at the University of New Hampshire. He worked on our antifouling studies from 1944 to 1946.

Ectoplasm

My first introduction to deep water fouling occurred in 1943 when I was working on a commercial fisheries problem in a New England seaport town. Amongst my acquaintances on the waterfront was an Ancient Hibernian who had once been on speaking terms with Leprechauns and other little people of the "Auld Sod" and was also familiar with certain supernatural matters in this country. He was an expert on spirits both ectoplasmic and fluid and when possessed by the latter he would become quite erudite about the the former. He told me the following story which he swore was true because he had gotten it only third hand from an unusually reliable source:

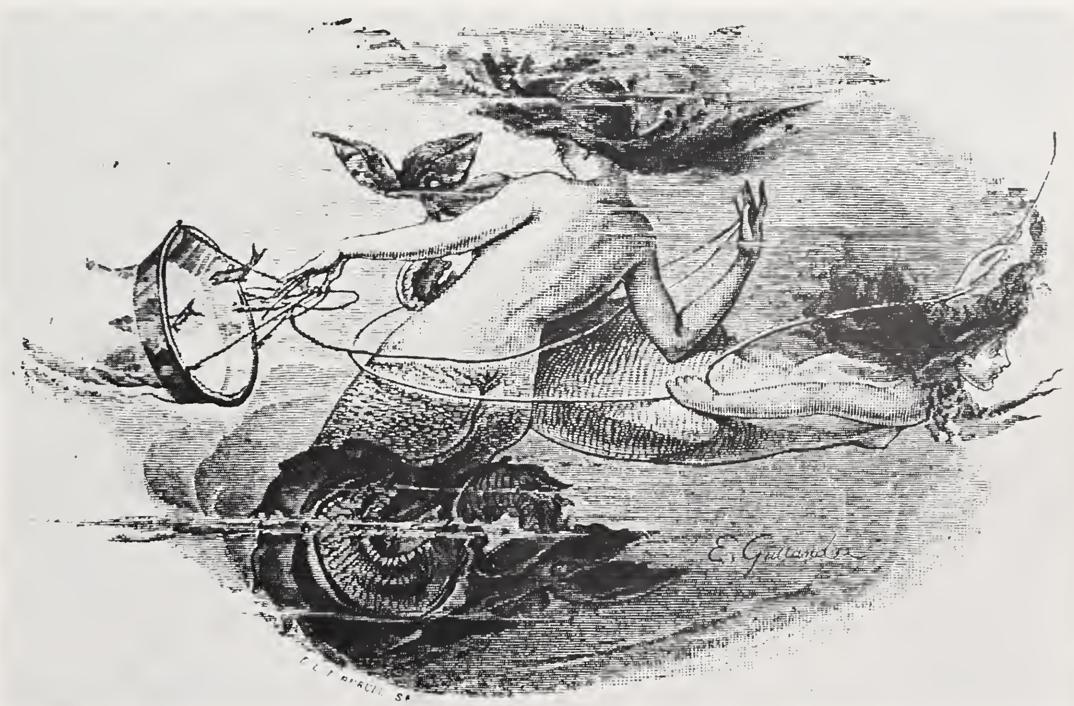
It seems that a young man and young lady were driving along a beach road late at night in an open car when a violent thunderstorm broke loose. The rain was so intense that it shorted the ignition system on the car and the couple took refuge in an abandoned ramshackle house which was the only shelter in the vicinity. They had no light, so could only huddle in the darkness and wait for the storm to abate. Around midnight an extraordinary flash of lightning illuminated the interior of the building and, in the brief moment of its duration, the horrified couple saw a weird figure clad in oilskins standing in the hall. The next flash of

lightning showed that the figure had gone.

When dawn broke, the storm was over and the frightened couple found a puddle of salt water where the apparition had stood. In the middle of the puddle there was a clump of seaweed of a kind not generally found in the locality. The couple picked up the seaweed and, after drying out the ignition of the car, took it to a botanist who determined that it was a species that grew on, and only on human corpses floating in the sea. Furthermore, the abandoned house in which the couple had taken shelter once belonged to a sea captain who was murdered and thrown overboard during a mutiny on the high seas. It was clear that the old boy's ghost had returned to its seaside home bringing its fouling with it. Apparently the seaweed was quite material because it remained behind when the specter dematerialized. To the Ancient Hibernian this was an authentic ghost story and to me it was a better than average yarn about deep ocean fouling. I couldn't bear to ask him who the botanist was that made the astounding diagnosis nor how possibly, but doubtfully, that particular species of plant propagated from one corpse to another. It might have shaken his faith in the supernatural.

See also: "Marine Fouling and its Prevention", U.S. Naval Institute, Annapolis 1952—Prepared for the Bureau of Ships, U.S. Navy, by the Woods Hole Oceanographic Institution. Our World War II studies on marine fouling were credited as: "having saved 10% of the Navy's fuel bill."

Sooner or later, most objects in the ocean are interfered with by marine life in one way or another.



(from the 'Challenger' Reports)

Monsoon Flight

By A. F. Bunker

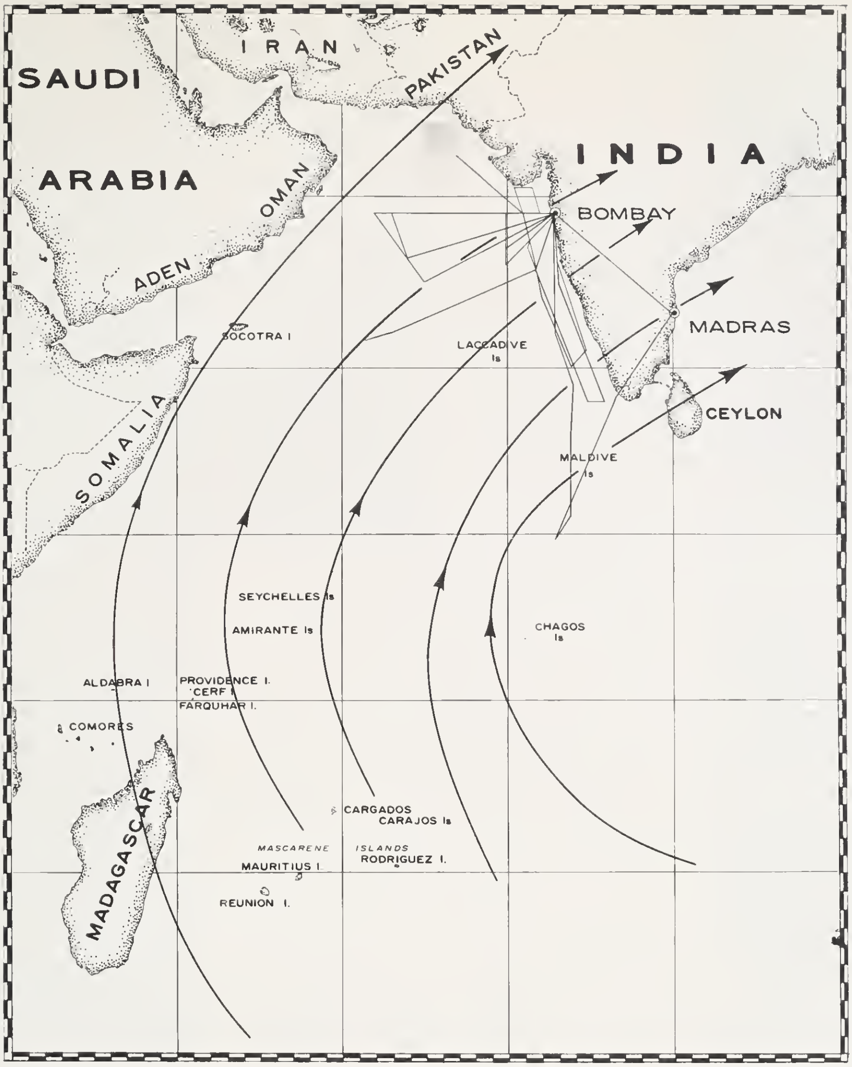
Research of the ocean circulation involves research of the atmosphere, particularly so in the Indian Ocean where the currents change with the monsoons.

FOR meteorologists the Indian Ocean study started with an invitation from the oceanographers to consider whether any unique meteorological problems were presented by the atmosphere flowing over that ocean whose study would justify traveling to the other side of the globe. It was quickly recognized that several factors existed that made the meteorological problems most intriguing. Here is a northern hemisphere subcontinent bound on the north by a high east-west mountain range and on the south by an expanse of water extending into the southern hemisphere where no land mass counterbalances the land. As a result of these and other factors, two very strong monsoon systems develop during the year. These monsoons have been studied for centuries by British and Indian meteorologists over the land masses of India, but have not been studied extensively over the ocean. Hence, it was decided that we should go ahead, in cooperation with the oceanographers, on an observational study of the general circulation, the cloud formations, the radiation flux, and the turbulent exchange of momentum, heat, and water vapor between the ocean and atmosphere. Further observations were to be made of the temperature, humidity and wind structure of the atmosphere and the rainfall.

A C-54 (DC-4) aircraft (Capt. Wm. Ewing) was bailed to the Institution by the U.S. Navy so that we could fly to India and make soundings and flux measurements of the monsoon system. The Office of Naval Research and the National Science Foundation supported the conversion and instrumentation of the former Marine Corps transport aircraft for meteorological and oceanographic research. Instruments installed in one of our aircraft for the first time are: A Doppler radar which allows better navigation and wind determination, an APS-42 radar, a turbulent gust probe, a refractometer for nearly-instantaneous humidity measurements, and a dropsonde chute and receptor. These, together with many modifications such as side, floor and roof blisters have changed the aircraft from a fine freight carrier to an even finer research aircraft.

Flight plans

The flight to the Indian Ocean turned out to be a last-minute wiring and shakedown cruise as we were trying to beat the monsoon to Bombay and could not afford to spend any more time at Woods Hole. As we landed in Bombay on June 12th, the last instrument was wired-up and the monsoon was just beginning! We set about making plans to cooperate with meteorologists of the



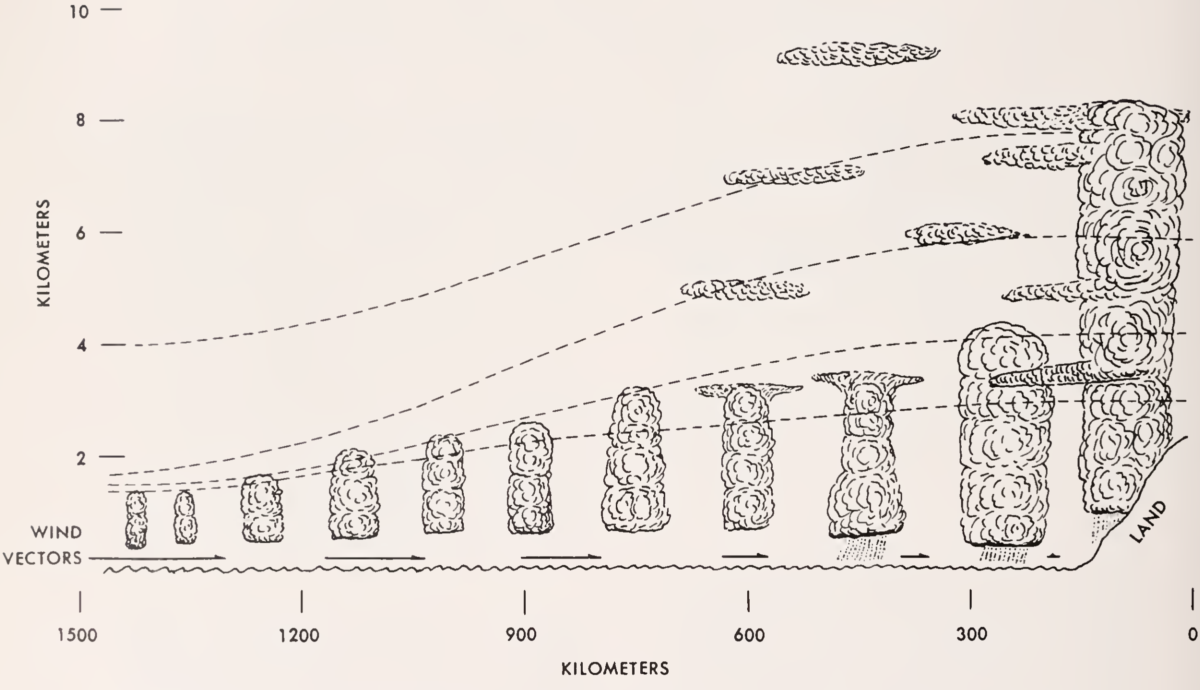
This chart shows the tracks of our aircraft and the wind streamlines in July during the summer monsoon.

International Meteorological Center at Colaba Observatory, Bombay, and the investigators of the U.S. Weather Bureau's Research Flight Facility (RFF) who were based at Bombay with their two DC-6's, a B-26, and a B-57 airplane. Our first trip plan was to fly a cross-section to the Royal Air Force base on the island of Gan south of the equator and to fly equatorial sections. These plans were changed by a cylinder on number 4 engine that cracked during the flight to Gan. After a temporary repair at Gan we limped back to Madras, leaving three of the scientific crew to be carried back to Bombay by the RFF. After a cylinder change, we devoted all of our time to flights out of Bombay to the areas of the Arabian Sea that the IMC weather charts indicated were most active or interesting. The accompanying map shows the tracks we flew observing the variations in the monsoon systems. On all of these flights we had Indian meteorologists aboard from either the IMC or the Indian Meteorological Service who gave us the benefit of their knowledge and local experience.

A normal flight procedure was to set a course from Bombay at low level, taking still and motion pictures of cloud formations. Another camera recorded position and time from the Doppler radar which registers ground speed and drift; while another film record was made of the search and weather radar.

Flight

At the end of a leg the plane would climb to 15,000 feet or higher for the return flight. Since the plane is not pressurized it was necessary to use oxygen masks from time to time but we believe that this is less of a handicap than the loss of flexibility if the cabin were pressurized, in which case it would not be so easy to move or modify camera ports and observation blisters.



As the air flowed toward India, the cumulus clouds pushed up into the stable air. Showers became common toward the land (right). This idealized sketch of the clouds, potential isotherms, and wind vectors is based on a small fraction of the data obtained and may be changed radically as more data are analyzed.

Our flights over the Arabian Sea gave us an opportunity to observe first hand the weather upwind from the Indian coast. After only a few flights, a significant and puzzling pattern to the monsoons became apparent. First, it was noted that the heaviest rainfall was associated with rather small discontinuous disturbances. These disturbances could shift geographically from day to day. Also, the activity of the cumulus clouds was much greater than one would anticipate in a stable atmosphere. Several hundred miles upwind of India very strong temperature inver-

sions were observed as low as three thousand feet above the sea surface. As the air flowed toward India the cumulus clouds pushed up into the stable air, producing many patchy layers of alto-stratus and decreasing the stability of the air. Showers became fairly common as the air approached the mainland. The interesting puzzle, that can be solved only after careful analysis of the data collected by the ships and aircraft of all the participating nations, is how the cumulus clouds can build up through such a stable atmosphere. From an inspection of the limited amount of data that we collected on our flights it appears that wandering areas of convergence in the lower, warm, nearly-saturated air furnish the ingredient required for the production of towering cumulus in the stable atmosphere. In addition to the migrating convergence areas, the mountains on the Indian west coast seem to produce a convergence of the air stream that extends nearly a hundred miles upwind.

In addition to five thousand feet of lapsed-time cloud photographs, we also stored data on turbulent gusts, temperature and humidity, on magnetic tape in analog form to be digitized by the addressor and fed into the Institution's computer, thereby saving considerable time and labor in data reduction.

It is our plan to return to the Indian Ocean in January 1964 and again in July 1964 for the next monsoon.

MR. BUNKER is a meteorologist on our staff since 1947. In the course of his studies he has flown some 1,000 hours on various meteorological aircraft.

Time lapse motion pictures showing cumulus clouds pushing up (left). At right several patchy layers of altostratus resulting from the moisture brought up by the cumulus clouds.

If anyone doubted the description that "the landing on the rocks was somewhat difficult", this view should dispel all doubts. For obvious reasons the rocks are given a wide berth by all ordinary ships.

St. Peter and St. Paul Rocks

00° 56′ North 29° 22′ West

WHEN we
Peter and St.
issue, no phot
landing. Sinc
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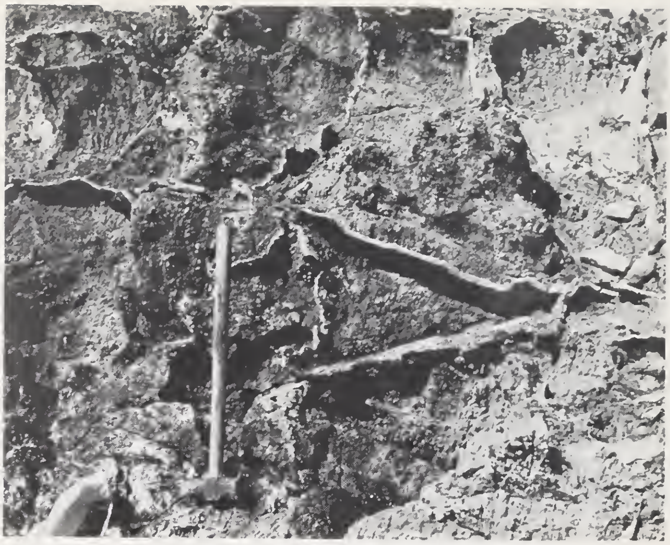
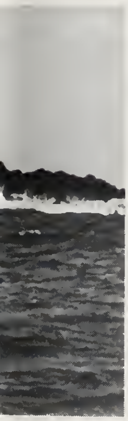
we present th
chromes made
18, 1963, durin

The only flat spot on the rocks is located near the lighthouse on southwest islet. Solid water and spray keeps filling the pools. A helicopter from the U.S.S. 'Atka' landed here in March 1955, thus for the first time using a sensible approach to get ashore.



Boxwork structures resulting from differential weathering of peridotite and a highly phosphatic calcareous mineral; found on the lower level of the rocks.



Two of our scientists inspecting the base of the lighthouse. Erected by Brazil, the lighthouse was not long in commission, reputedly due to earthquake activity. Thousands of boobies, seen flying through the air, have deposited a white layer of guano on the rocks.

**published the article on St.
Paul Rocks, in the June 1963
graphs were available of our
few people have ever seen
d fewer still will land there,
ese photographs from koda-
by Ian MacGregor on March
'Chain' cruise #35.**

These shoreline rocks give evidence of fracture by directional stresses. Precise measurements may give information as to the direction from which the stresses were applied.

Indian Ocean

Aden

Bombay

Colombo

Zanzibar

By E. E. HAYS

The 'Atlantis II' (Captain E. H. Hiller) left Woods Hole on July 5, 1963, on her first major cruise to participate in the International Indian Ocean Expedition. The 21 men scientific party, headed by chief scientist A. R. Miller, was augmented from time to time by scientists from other countries. The ship will return to Woods Hole just before Christmas.

'ATLANTIS II' departed Aden on August 5, 1963, and the Indian Ocean part of the cruise began in earnest. The many hours of preparation and the work done in transit were history — now the major effort would begin.

Chief scientist A. R. Miller had talked to the new Royal Research Ship 'Discovery' and modified his original Gulf of Aden plans to compliment the recent work of that ship. We were not to see the 'Discovery' until several months later near the Seychelles at which time she was manned by a different scientific compliment whose interest was geophysics, rather than physical oceanography. Our British colleagues were most cooperative in supplying us with some empty reels for wire.

The general cruise plan was to cross eastward on latitude 15°N. and stop at Bombay. From Bombay "Atlantis II" would work northward along the shelf to 20°N.,* cross the Arabian Sea westwardly and slant southwesterly from the Arabian Coast to Socotra returning eastwardly on 10°N. to the Indian coast and making Colombo, Ceylon. From Ceylon, she would head southerly to 5°N. and run toward Mombassa; after reaching 400 fathoms of water, a southeasterly course would be laid toward the Seychelles, but the ship would almost reverse course towards Zanzibar as the tropical paradise of the Seychelles came within view.

As station followed station, the timelessness of oceanographic cruises took over. The days of the week were based on movie days and Joe Lambert's menu rather than a weekly list of engagements and schedules. The stations varied in scope and length of time. The shorter were the shallow water, single-cast, hydrographic stations — the longest was a reference station at which the complete bag of tricks was tried. This included plankton net hauls, hydrographic stations, deep layer volume sampling for C^{14}, in situ gamma ray measurement, sound velocimeter lowering, wave spectrum recording, particulate matter water samples, extensive sampling to several hundred meters for plankton analysis and other collections.

Rolling along

Weather reports from ships arriving in Aden from the east were discouraging, large seas, and high winds were the experiences — but the southwest Monsoon and its effects were to be studied, and this could not be done at Aden. Running to Bombay with the southwest Monsoon was not uncomfortable — all however noted the effectiveness of the anti-roll tanks as compared to the earlier behavior of 'Atlantis II.' The roll had a slight delay at each extreme as the momentum of the water counteracted the ship's tendency to roll back, which is somewhat different than the way most ships roll.

* See chart on page 9

MUNNS

The Royal Research Ship 'Discovery' new from the builders, close by the 'Atlantis II' fresh from her yard. Their namesakes: 'Atlantis' and 'Discovery II' also worked together.

The most unpleasant weather of the two-month period was encountered on the run from the Arabian coast to Socotra. Running directly into the southwest winds, that seemed to average nearly 40 knots, 'Atlantis II' had to reduce speed considerably to eliminate pounding. Even at slow speed the phase relation of ship motion and wave crests would result in a crashing collision from which the whole ship would shudder, and one could only marvel that the instruments in the top lab survived and continued to operate.

The wind and Somali current combined to make lowerings south of Socotra somewhat unusual. To keep the wire vertical it was necessary to use an average of 120 rpm on both screws, an equivalent of a forward speed of six to seven knots. The water temperature at the surface surprised several, being only 17°C., not the hot Indian Ocean we had anticipated. Although this was one of the most interesting areas encountered — biologically and otherwise — it was with a sigh of relief we started eastwardly to Colombo.

The rest of the weather was ideal, clear warm days, rather cool nights, only in the Socotra area did we encounter much overcast.

Although the main scientific effort was made at the stations, a continuing program was carried on during transit. Echosounding records, total magnetic field determinations, extensive weather observations—including radio-sonde flights, and data collection for study of a new very low frequency radio navigation system; all were part of the regular program. The computer capability and use grew during this time as programs were written and checked out, and the machine became part of the working unit.

Many guests

The guest book of 'Atlantis II' prospered in the ports as might be expected. Visitors from business, governments, and schools came and expressed their delight in the ship — and the opportunity to be shown about. Ostensibly days to relax and recover, the days in port for many, and in particular the Chief Scientist, were a steady round of interviews and discussions concerning the ship.

The crossing of the Equator with appropriate rites of Neptune et al. were well done. All hands, including the Pollywogs enjoyed the affair.

The most unusual occurrence during the period happened when a group of sixteen from the ship enjoyed the final night of a religious festival in a small village, including a parade, a four mile walk, and a display of fire walking that was almost unimaginable.

The most impressive part about the cruise was 'Atlantis II' men and ship. They are a combination that will be very difficult to match anywhere.

Game Fish Migrations

By F. J. MATHER III

FROM A KODACHROME BY A. R. TURNER

NEW information on the migratory cycles of several game fish is being obtained at an accelerating rate.

With the increasing cooperation of fishermen and scientists, the Institution's cooperative game-fish tagging program has led to some 11,700 fishes being tagged from May 1954 to October 1963 while 157 returns have been recorded. This volume of tagging the swift and roving game fish was made possible by the dart tag developed at the Institution. Large and powerful fish can be marked without having to remove them from the water, a virtually impossible task if the fish is to survive.

School tuna milling under a boat off Nomansland, Mass. Eight out of 29 bluefin tuna tagged this summer were recaptured in the same general area.
Commercial seiners off New England go after these fish, while the northern European fisheries concentrate on the giant tuna.

THE most spectacular results have been the seven trans-atlantic migrations of bluefin tuna shown by recaptures in 1959, 1961, and 1962. Especially notable were the migrations from Cat Cay, Bahamas, to Norwegian waters of two giant bluefin in the summer of 1961 and of one in the summer of 1962. The first two fish required only 118 and 119 days, respectively, for the 4,500 nautical mile trip, and the last made it in a mere 50 days! The lean condition of these tunas, when recaptured, in contrast to the normally heavy local fish has led Norwegian and German scientists to believe that they can distinguish the bluefin arriving from the western Atlantic from their eastern Atlantic cousins by their body condition. The Europeans are now pursuing studies of the annual contributions of "American" tunas to the northeastern Atlantic catches, utilizing statistics foresightedly gathered over the past decade. Their

results, as well as the comparison of the rates of recapture in Norwegian waters of tunas marked there and in the Bahamas indicate that these contributions have been important in some years. So far in 1963, despite the fine efforts of sportsmen who marked 143 giant bluefin in the Bahamas, no transatlantic recoveries have been made. This may partly be due to the fact that the northeastern Atlantic tuna landings in 1963 were unprecedently small and late. An interesting sidelight is that the western Europeans like the giant tuna whereas the northeastern American catch concentrates on the small school tuna.

BARTLETT

Tagging a giant—Mr. Mather in peaked cap (center) about to cut away a tuna after tagging. All large fish are released by cutting the leaderwire. This does not seem to bother the fish. The wire and hook soon rust out, as is evidenced by recaptured fish.

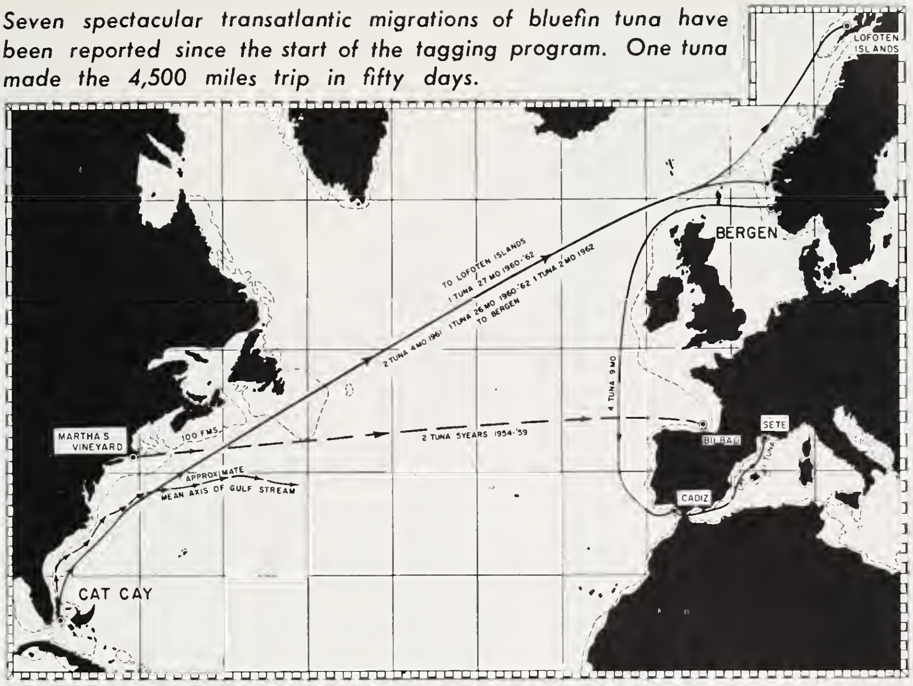
Taggings and returns recorded up to October 8, 1963

Species	Taggings	Returns	Percent
Bluefin tuna	1,509	32	2.2
Yellowfin tuna	198	—	—
Yellowfin tuna (Pacific)	4	2	50.0
Bigeye tuna	43	—	—
Blackfin tuna	61	—	—
Albacore	27	—	—
Skipjack (Oceanic bonito)	51	—	—
Little tuna	162	—	—
Atlantic bonito	52	—	—
Sailfish	4,303	30	0.7
Sailfish (Pacific)	907	—	—
White marlin	2,331	3	0.1
Striped marlin (Pacific)	600	—	—
Blue marlin	138	—	—
Black marlin (Pacific)	44	—	—
Broadbill swordfish	5	—	—
Dolphin	126	3	2.3
Greater amberjack	747	70	9.4
Crevalle jack	30	5	17.9
Bar jack	1	1	100.0
Bluefish	23	—	—
Striped bass	49	7	14.3
Great barracuda	46	2	4.3
Miscellaneous	186	2	1.1
Total	11,643	157	1.3

Increased returns

The recent expansion of the purse seine tuna fisheries in the northwestern Atlantic has resulted in a startling increase in local bluefin recoveries. From 1954 through 1962 we received just six western Atlantic returns. By October 1963 we had already received 19 tags from locally recaptured bluefin tuna. Eleven of these came from tuna marked this year, four were marked in 1962, three in 1961 and one in 1960. Of 29 tags applied to school tuna in the seining area in 1963 (between Maryland and Cape Cod) eight were recaptured

Seven spectacular transatlantic migrations of bluefin tuna have been reported since the start of the tagging program. One tuna made the 4,500 miles trip in fifty days.



already in the same area. It is possible, because of the small numbers involved that this high return rate is due in part to chance. However, the urgent and immediate need for greatly increased tagging is obvious.

The heavy tagging of Atlantic sailfish has resulted in 30 recoveries. Most of these have been marked and recaptured off southeastern Florida, the area of most intensive fishing for this species, but two returns showed migrations from this region to St. Petersburg, on the Gulf coast, and Morehead City, North Carolina respectively. The lower return rate for white marlin is perhaps due to lower fishing pressure on this fish, and also to greater oceanic dispersal as shown by recent longline explorations. Recaptures of good-sized sailfish and white marlin after periods of a year or more at liberty suggest that the life span of these species may not be as short as has been believed. Those who are surprised at the low return rates for the bill fishes should note that they are caught almost entirely by sport fishing. Had we been dependent on the sportfishery for tuna recoveries, we would now have just one, yielding an even lower rate than those for Atlantic sailfish and white marlin. The lack of returns from Pacific bill fish may be due to the much smaller and more dispersed sport fishing effort in that ocean.

While heavy commercial fishing is apparently needed to produce substantial return rates of the truly oceanic fishes, this is not true for some of the more coastal species, such as the amberjacks, jacks, and striped bass. The overall return rate for the reef-dwelling greater amberjack, for example, approaches 10 percent, with much higher rates indicating heavy sport fishing pressure in certain localities. Few of the returns indicate much movement, the longest migrations being about 90 miles. Similarly, the recaptures of crevalle jack and striped bass show considerable sport fishing mortality for these inshore game fishes.

It is clear that interesting and valuable information is being obtained by the tagging program, but that it is too early to draw definite conclusions. Far more fish need to be tagged in order to determine migrations, growth rates and fishing pressure. This comparatively low cost program is financed by many organizations and individuals (see: Associates' News in this issue). We are dependent upon the fishermen, both sport and commercial, to do most of the tagging and to examine fish caught for tags, and are most sincerely grateful to the more than 1600 persons who are assisting us.

MR. MATHER, research associate in oceanography, is a well known game fisherman who goes after fish as well as studying them.

HIGH

By R. S. SCHELTEMA

Oceanographic instrumentation has been greatly improved and is being improved, but deep sea dredging is not much different than it was one hundred years ago.

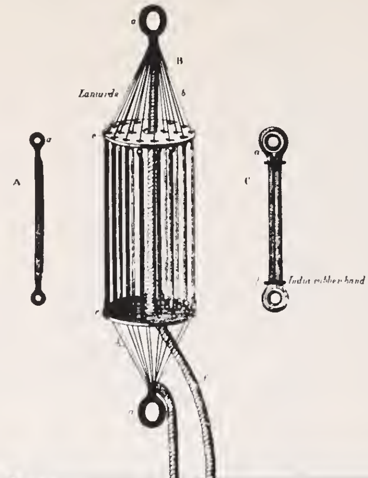
SINCE the great 'Challenger' expedition of 1872-1876, the basic methods used in collecting organisms from the deep sea bottom seem to have changed but little. It is both profitable and amusing, after an interval of ninety years, to look into the past and present and to observe carefully how little has actually occurred during this time.

The unnamed gentleman on board the 'Challenger' is supervising a seaman, sifting deep sea sediments for marine life. At left, the author typifies the modern "do-it-yourself" school on board the 'Atlantis'.

Deep Sea

Biological dredging

Compare for example the dredging method used on the 'Challenger' with that on our modern research ships. The 'Challenger' had lines: "2, 2½, and 3 inches in circumference . . . made of the best Italian hemp, tarred, well hackled and rubbed down", with a breaking strain from 1600 to 2550 kilos (3500 to 5600 pounds) and spliced together to form a length of 4000 fathoms which was coiled on the forecastle. The two-inch rope was most frequently used for deep trawling and dredging because it was strongest in proportion to its weight, 158 pounds per 100 fathoms, with a breaking strain of 2 tons 6 cwt. In deep sampling, very little margin over the breaking strength was left for friction of the water, sudden accidental jerks on the line, or the rolling of the vessel. Accordingly, when dredging, great care was required to prevent undue stress on the line, and large accumulators were used consisting of rubber bands three feet long and ¾ inches thick which could be stretched to a maximum of about 17 feet. As many as eighty of such rubber bands were used which together could support two and one half tons or the breaking strain of the line. The accumulators were attached to blocks high up on the yard, thus enabling them to expand and contract freely. "When the dredge had been on the bottom a sufficient time—from half an hour to an hour —the rope was brought to the [18 horsepower] donkey engine and the dredge hove up. . . The strain on the lines was so great that the men could not hold on to it while it was being hove in, when turns were passed round [but] one drum of the engine."



Dredging and sounding arrangements on board the 'Challenger'. A beam trawl hangs over the port side suspended from an accumulator shown in the detailed view.

The careful observer can find the heavy steel spring accumulator on the deck of the 'Atlantis' which prevents strain on the ½ inch trawl wire. The major objects are Otto Solberg delivering a haircut and F. J. Mather trimming his beard.

FAY

Wire and Springs

Now, on our modern oceanographic ships, the largest single improvement for dredging has been the use of half-inch steel wire with a breaking strain of 24,000 pounds or about 12 tons. Such wire, in addition to having greater strength (approximately five times that of the 'Challenger'), also has the advantage of being easier to handle and requiring less storage space. The accumulators now used are constructed of very heavy steel springs which take up the greater strain required of them owing in part to the increased weight of the wire over that of hemp line. On our newest research vessel 'Atlantis II', steam is again being used to power the main winch, but this engine of about 150 horsepower, is approximately eight times more powerful than the one in use on the 'Challenger.'

Electronics Age

Recently the electronics age has made possible the only other major contribution in easing the task of dredging in the deep sea. This is the so called "pinger" which is a sound source attached near the end of the wire just above the dredge. This instrument makes it possible to know, on deck, the position of the dredge relative to the bottom. Now, as in the days of the 'Challenger', the foremost difficulty in dredging is to know when the dredge has arrived on the ocean bottom. Yet, even with the use of a "pinger", we more than once have brought the dredge to the surface empty, and currently the "pinger" is not used routinely by us in biological dredging.

What is the improvement actually realized in dredging time and in the percentage of successful hauls between the 'Challenger' and our own ships? A typical station of about 4000 meters took about six and three quarters hours aboard the 'Challenger', whereas on the 'Atlantis' we recently took a similar station of approximately equal depth in two hours and fifty minutes. With respect to the percentage successful hauls, the 'Challenger' had an enviable record. During her three and one half years service, she made 354 deep sea dredge and trawl stations and lost but eleven of these through failure of the gear.

The processing of bottom samples after they reach the deck is still extraordinarily similar to that used on the 'Challenger'. The major difference seems to be that the scientist no longer dresses in jacket, tie and straw hat, but instead wears foul weather gear and boots, or shorts and sneakers. The significance of this change in style is left to the reader, who will no doubt understand it with but a moment's reflection.

Bringing in the dredge
'Challenger'—1873 'Atlantis'—1962

OWEN

Tubs and Sieves

On the 'Challenger': "Close to the place where the dredge was emptied there was always one or two tubs, . . . each of which was provided with a set of sieves, so arranged that the lowest sieve fitted loosely within the bottom of the tub, and the three succeeding sieves within one another. The sieves were put into the tub, which was then filled up to the middle of the top sieve with sea water. The top sieve was then half filled with the contents of the dredge, and the set of sieves gently moved up and down in the water. . . The result of the process was that . . . the larger organisms were washed and retained in the upper sieve . . . the three remaining sieves contained, in graduated series, the objects of intermediate size." The sieves were carefully examined, and: "the organisms which they contained gently removed with a pair of brass or bone forceps into jars of sea water, or placed at once in bottles with spirits of wine."

Dredging

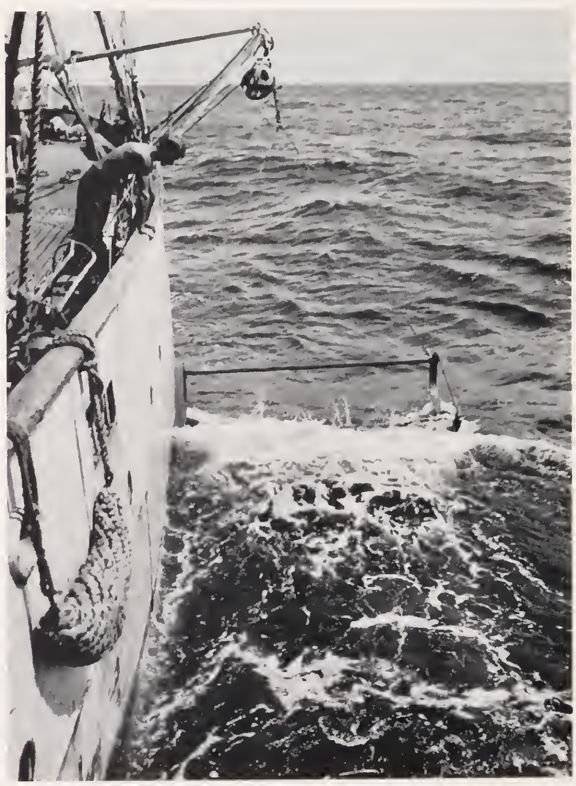
The procedure just described from the **Report of the Scientific Results of the Voyage of H.M.S. Challenger** differs only in small details with that used today. The major difference comes from the increased volume of sediment (ca. 0.1 m^3) that we now are able to collect. The deep sea anchor dredge used for biological work at Woods Hole and originally developed by Dr. H. Sanders, Dr. R. Hessler and Mr. G. Hampson, is between 400 and 500 pounds, much heavier than the dredge of 85 pounds which was necessarily used for the deeper stations of the 'Challenger' (up to 6975 meters). The 'Challenger' dredge was: "intended to skim the surface off the bottom and throw it into the sack . . . made of a network of soft line (something like marline) in very small meshes. . . It was lined inside with cotton cloth or 'bread-bag stuff' so as to prevent minute animals being washed out whilst heaving in. . ." This dredge tended to catch some of the larger organisms on the surface. On the other hand the deep sea anchor dredge now used in our biological work is designed to take a bite of a predetermined size from the bottom, and for capturing animals living within the sediment, the so-called "infauna". It was specifically intended to take quantitative samples.

The infauna, in terms of numbers of organisms, now turns out to be by far the greatest fraction of the total animal life on the ocean floor. These organisms are, however, all of very small size, only a few of them exceeding two inches in length and the large majority being under one inch. On the 'Atlantis' the organisms must still be patiently picked from the screens with forceps (now stainless steel) and placed in "spirits of wine" or some other preservative.

The 'Challenger' brought to the surface hundreds of new creatures, species previously unknown to man, but interestingly enough in the mid-20th century we are still doing so.

DR. SCHELTEMA came to the Institution as a Summer Fellow in 1956, '57, and '58. He was appointed research associate in Marine Biology in 1961.

Bringing in the beam trawl
'Challenger'—1873 'Atlantis'—1948



FAY

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Associates' News

Game fishing

WITH reference to the gamefish article on page 16 it is of interest to note that over 1600 sport fishermen, more than 30 of them Woods Hole Oceanographic Institution Associates, have cooperated in the program by tagging some of their catches. Several angling clubs and tournament committees have encouraged the marking of game fishes. A great many taggings have resulted from the cooperation of the U. S. Bureau of Commercial Fisheries, and some commercial fishermen have marked tunas. The "tag and release" flag, financed by the Associates and distributed to cooperating taggers, has been given official status by the International Game Fish Association, Mr. William K. Carpenter, President. The basic financial support of this program by the National Science Foundation has been augmented by grants from the Lou Marron Science Fund, the Sport Fishing Institute, the Charles W. Brown, Jr., Memorial Foundation, The International Game Fish Association, the National Geographic Society, the Associates, and by donations from several anglers and sportfishing organizations.

Bequest received

A BEQUEST of $100,000 from the estate of the late Lucius Hilliard Barbour will be received by the Institution. This is the first major gift to the endowment fund and the first bequest by will that the Institution has received since its founding in 1930.

"Hilly" Barbour was a research associate at the Institution from 1943 to 1955 engaged mostly in underwater acoustics. He cruised on the Atlantis, the Anton Dohrn and the Physalia. Almost daily while he was at the Institution he could be found surrounded by friends at lunch time in the "Little New Yorker". His pleasant wit and geniality, his love for the sea, and his ability to handle a sailing ship made him a grand companion.

"It is especially pleasing to receive this gift from someone who was so close to the Institution — a truly wonderful and inspiring gesture", stated Dr. Paul M. Fye, Director, "One of the important needs of an Institution such as ours is to increase our endowment to provide a solid future for our scientific work."

Mr. Barbour died on July 25th, 1963. He is survived by his widow, Elizabeth Breslau Barbour of Woods Hole.

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An article on the natural resources of the ocean will appear in the December issue of FORTUNE magazine. Written by George Boehm, many of our staff members were interviewed last summer.

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The Associates of the Woods Hole Oceanographic Institution are a group of individuals, corporations and other organizations who, because of their love for the sea and interest in science and education, support and encourage the research and related activities of the Institution.

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